AMENDMENTS TO THE CLAIMS

This listing of the claims replaces any prior listing of the claims.

1. (Original) A device for identifying a condition in a fluid system and initiating a response, said device comprising:

a sensor for placement in communication with a fluid in said fluid system, said sensor outputting a first signal in response to a first condition of said fluid and a second signal in response to a second condition of said fluid; and

a control means for receiving said first signal and said second signal and for sending at least one command signal for initiating a response based on said received signals.

2. (Original) The device of claim 1 wherein said first condition is said fluid in a gaseous state and said second condition is said fluid in a liquid state.

3. (Original) The device of claim 2 wherein said sensor and control means are placed in a fluid system.

4. (Original) The device of claim 3 wherein said fluid system comprises a fluid conduit having an input end and an output end connected to a fluid movement means for moving an aliquot of fluid, said fluid movement means responsive to a fluid movement command signal.

5. (Original) The device of claim 4 wherein said fluid movement means is a metering syringe.

6. (Currently amended) The device of claim ~~6~~ 4 wherein said sensor communicating with said fluid is disposed between said fluid movement means and said output end.

7. (Original) The device of claim 6 wherein said control means issues at least one command signal in response to a condition.

8. (Original) The device of claim 7 wherein said control means issues at least one fluid movement command signal for causing said fluid movement means to draw fluid in through said input end at a rate.

9. (Original) The device of claim 8 wherein said control means issues at least one fluid movement command signal for increasing said rate while receiving said second signal and at least one fluid movement command signal for decreasing said rate while receiving said first signal, wherein said fluid is moved at an optimum rate that prevents vaporization of said fluid.

10. (Original) The device of claim 8 wherein said control means stops issuing said fluid movement command signals to said fluid movement means upon receiving said first signal, wherein said fluid in a gaseous state does not pass said sensor.

11. (Original) The device of claim 6 wherein said fluid system further comprises a positioning means for moving said input end between at least one source of liquid and at least one source of gas, said positioning means responsive to a position command signal to move said input end.

12. (Original) The device of claim 11 wherein said control means issues at least one fluid movement and position command signal for causing said fluid system to draw aliquots of liquid from said at least one source of liquid into said fluid system to fill said fluid system with liquid and then for causing said fluid system to draw and count a plurality of aliquots of gas from said at least one source of gas into said fluid system until said first signal is received by said control means.

13. (Original) The device of claim 12 wherein said control means multiplies the volume of each aliquot by said counted number of aliquots of gas drawn into said fluid system to determine a volume of said fluid conduit.

14. (Original) The device of claim 11 wherein said control means issues at least one fluid movement and position command signal for causing said fluid system to draw an aliquot of gas from said at least one source of gas into said fluid system and then for causing said fluid system to draw and count a plurality of aliquots of liquid from said at least one source of liquid into said fluid system until said first signal is received by said control means.

15. (Original) The device of claim 14 wherein said control means multiplies the volume of each aliquot by said counted number of aliquots of liquid drawn into said fluid system to determine a

volume of said fluid conduit.

16. (Original) The device of claim 15 wherein said control means determines said volume of said fluid conduit and compares said volume to a control value to detect a reduction in said volume of said fluid conduit.

17. (Original) The device of claim 16 wherein said control value is a previous value of said volume.

18. (Original) The device of claim 17 wherein said control value is an average of previous values of said volume.

19. (Original) The device of claim 15 wherein said fluid system further comprises an aspirating needle connected to said input end.

20. (Original) The device of claim 19 wherein said fluid system has a fluid path comprising a valve means disposed between said aspirating needle and said input end, said valve means having a plurality of positions wherein fluid is allowed to flow through said valve means, said valve means responsive to a valve command signal to assume one of said positions.

21. (Original) The device of claim 20 wherein said control means sends at least one fluid movement command, valve command and position command signal to control said fluid movement means, said valve means, and said positioning means in conjunction with receiving said first signal and said second signal to determine a needled volume of said fluid path.

22. (Original) The device of claim 21 wherein said valve means has a valve volume and said control means determines a volume of said aspirating needle by subtracting said volume of said fluid conduit and said valve volume from said needled volume of said fluid path.

23. (Original) The device of claim 20 further comprising a sample loop in communication with said valve means in said fluid path and a source of sample liquid as one of said at least one source of liquid.

24. (Original) The device of claim 23 wherein said valve means further has a loop position wherein fluid is allowed to flow through said sample loop and through said valve means, said valve means further responsive to said valve command signal to assume said loop position.

25. (Original) The device of claim 24 wherein said control means sends at least one said position command, said valve command and said fluid movement command signal to said positioning means, said valve means and said fluid movement means in conjunction with receipt of said first signal and said second signal to pull an aliquot of gas and multiple aliquots of sample liquid sequentially through said aspirating needle into said sample loop and ceases sending said fluid movement command signals when said first signal is received by said control means.

26. (Original) The device of claim 25 wherein said control means determines a volume of fluid in said sample loop by determining an open volume of said fluid path with said valve in said open position and then determining a loop volume of said fluid path with said valve in said loop position and subtracting said open volume from said loop volume.

27. (Original) The device of claim 19 wherein said fluid system further comprises a pressurizing means connected to said source of liquid, said pressurizing means responsive to a pressurize command signal to apply a predetermined pressure on said source of liquid.

28. (Original) The device of claim 29 wherein said control means determines a compliance rate volume of said fluid system by sending at least one said position command, said valve command, said pressurize command and said fluid movement command signals to control said positioning means, said valve means, said pressurizing means and said fluid movement means in conjunction with receiving said first signal and said second signal to determine a difference in an ambient volume of said fluid path when said fluid in said fluid path is under ambient pressure and a pressurized volume of said fluid path when said fluid in said fluid path is under an elevated pressure.

29. (Original) The device of claim 28 wherein said control means determines a leak rate by

sending at least one said position command, said valve command, said pressurize command and said fluid movement command signal to control said positioning means, said valve means, said pressurizing means and said fluid movement means in conjunction with receiving said first signal and said second signal to form a gaseous region comprising aliquots of gas preceded by a computed volume of liquid between said gaseous region and said device and to determine a change in said pressurized volume of said fluid system after said fluid system is maintained at an elevated pressure for a predetermined length of time.

30. (Original) The device of claim 14 wherein said fluid system further comprises a sealing means, said sealing means operative to seal said input end when said positioning means positions said input end against said sealing means in response to at least one position command from said control means.

31. (Original) The device of claim 30 wherein said control means determines a leak rate of said fluid system, by sending at least one said position command and said fluid movement command signal to control said positioning means and said fluid movement means in conjunction with receiving said first signal and said second signal to form a gaseous region comprising a predetermined number of aliquots of gas surrounded by liquid and to determine a change in the volume of said gaseous region when said fluid system is maintained under less than ambient pressure for a predetermined length of time and then returned to said ambient pressure.

32. (Original) The device of claim 3 wherein said fluid system comprises a liquid chromatography system.

33. (Original) The device of claim 32 wherein said fluid system comprises an injector for a liquid chromatography system.

34. (Original) The device of claim 1 wherein said sensor comprises:

a light emitter constructed and arranged to emit light through said fluid, said light emitter producing a beam of light, which beam of light, after traveling through said fluid has a first characteristic in the presence of a liquid and a second characteristic in the presence of a gas; and

a light receptor constructed and arranged to receive light from said fluid, said light receptor producing said first signal in response to light having said first characteristic and said second signal in response to light having said second characteristic, wherein said control means may distinguish the presence of said gas or said liquid in said fluid system.

35. (Original) The device of claim 34 wherein said fluid system comprises at least one vessel for containing said fluid, said vessel having at least one wall having a transparent portion, said sensor communicating with said fluid through said transparent portion of said vessel.

36. (Original) The device of claim 35 wherein said vessel is a tube.

37. (Original) The device of claim 36 wherein said tube is transparent.

38. (Original) The device of claim 37 wherein said light emitter is constructed and arranged to pass light into said tube through said at least one transparent portion and said light receptor is constructed and arranged to receive light from said tube through said at least one transparent portion.

39. (Original) The device of claim 37 wherein said sensor is a bubble detector.

40. (Original) A method for moving fluid in a fluid system comprised of a fluid conduit having an input end and an output end and a fluid movement means for moving an aliquot of fluid, said fluid movement means responsive to a fluid movement command signal, the method comprising:

a. providing a device comprising:

a sensor for placement in communication with a fluid in said fluid system, said sensor outputting a first signal in response to said fluid being in a gaseous state and a second signal in response to said fluid being in a liquid state; and

a control means for receiving said first signal and said second signal and for sending at least one command signal for initiating a response based on said received signals;

b. placing said sensor disposed between said fluid movement means and said output end in communication with said fluid;

c. connecting said control means fluid movement command signal to said fluid movement means; and

d. said control means issuing at least one fluid movement command signal for causing said fluid movement means to draw fluid in through said input end at a rate.

41. (Original) The method of claim 40 for moving a liquid at an optimum rate that prevents vaporization, the method further comprising said control means issuing at least one fluid movement command signal for increasing said rate while receiving said second signal and issuing at least one fluid movement command signal for decreasing said rate while receiving said first signal.

42. (Original) The method of claim 40 for preventing fluid in a gaseous state from passing said sensor, the method further comprising said control means no longer issuing said fluid movement command signals to said fluid movement means upon receiving said first signal.

43. (Original) The method of claim 40 for determining a volume of said fluid conduit in said fluid system that further comprises a positioning means for moving said input end between at least one source of liquid and at least one source of gas, said positioning means responsive to a position command signal to move said input end, said method comprising: replacing step d with:

d. connecting said control means position command signal to said positioning means;

e. commanding said fluid system to draw an aliquot of gas from said at least one source of gas into said fluid system;

f. commanding said fluid system to draw and count a plurality of aliquots of liquid from said at least one source of liquid until said first signal is received by said control means; and

g. determining said volume of said fluid conduit by multiplying the volume of an aliquot by said counted number of aliquots of fluid drawn.

44. (Original) The method of claim 40 for determining a volume of said fluid conduit in said fluid system that further comprises a positioning means for moving said input end between at least one source of liquid and at least one source of gas, said positioning means responsive to a position command signal to move said input end, said method comprising: replacing step d with:

d. connecting said control means position command signal to said positioning means;

e. commanding said fluid system to draw aliquots of liquid from said at least one source of liquid into said fluid system until said fluid system is filled with liquid;

f. commanding said fluid system to draw and count a plurality of aliquots of gas from said at least one source of gas until said first signal is received by said control means; and

g. determining said volume of said fluid conduit by multiplying the volume of an aliquot by said counted number of aliquots of gas drawn.

45. (Original) The method of claim 43 for detecting an obstruction in said fluid system, the method further comprising comparing said volume of said fluid conduit to a control value and identifying an obstruction when said volume is less than said control value.

46. (Original) The method of claim 43 applied to a fluid system that further comprises an aspirating needle connected to said input end wherein the method determines a volume of a fluid path comprising said aspirating needle and said fluid conduit combination.

47. (Original) The method of claim 46 applied to a fluid system that further comprises a valve means disposed between said aspirating needle and said input end, said valve means having a plurality of positions wherein fluid allowed to flow through said valve means, said valve means responsive to a valve command signal to assume one of said positions wherein the method determines a volume of a fluid path comprising said aspirating needle, fluid conduit and valve means combination.

48. (Original) The method of claim 47 for determining a volume of said aspirating needle in a fluid system that further comprises a valve volume of said valve means, the method comprising subtracting said valve volume and said fluid conduit volume from said combination volume.

49. (Original) The method of claim 47 wherein said fluid system further comprises a sample loop in communications with said valve means and said valve means further has a loop position wherein fluid is allowed to flow through said sample loop and through said valve means, said valve means further responsive to said valve command signal to assume said loop position.

50. (Original) The method of claim 49 for determining a volume of said sample loop comprising

determining an open position volume of said fluid system with said valve means in said open position;

determining a loop position volume of said fluid system with said valve means in said loop position; and

determining said loop volume by subtracting said open position volume from said loop position volume.

51. (Original) The method of claim 49 for positioning a liquid in said sample loop comprising:

commanding said valve means to assume the loop position;

commanding said fluid system to draw an aliquot of gas from said at least one source of gas into said fluid system; and

commanding said fluid system to draw a plurality of aliquots of liquid from said at least one source of liquid until said first signal is received by said control means.

52. (Original) The method of claim 43 for determining a compliance rate volume in a fluid system that further comprises a pressurizing means connected to said source of liquid, said pressurizing means responsive to a pressurize command signal to apply a predetermined pressure on said at least one source of liquid, said method comprising:

commanding said fluid system to fill said fluid system with liquid from said liquid source;

measuring an ambient volume of said fluid system;

commanding said fluid system to fill said fluid system with liquid from said liquid source;

issuing a pressurize command to place said fluid system under elevated pressure;

measuring a pressurized volume of fluid system; and

determining said compliance rate volume as the difference between said pressurized volume and ambient volume.

53. (Currently amended) The method of claim 52 for determining a leak rate in a fluid system, said method comprising:

filling said fluid system with said liquid from said liquid source;

issuing a pressurize command to place said fluid system under elevated pressure for a predetermined length of time;

determining a delayed pressurized volume;

determining a difference between said pressurized volume and said delayed pressurized volume; and

converting said difference to a leak rate.

54. (Original) The method of claim 43 wherein said fluid system further comprises a sealing means, said sealing means operative to seal said input end when said positioning means positions said input end against said sealing means.

55. (Original) The method of claim 54 for determining a leak rate of said fluid system, the method comprising:

commanding said fluid system to draw a predetermined plurality of aliquots of gas into said fluid system previously fill with liquid;

commanding said fluid system to draw a plurality of aliquots of liquid into said fluid system forming a gas bubble in said fluid system;

sealing said input end and creating a negative pressure in said fluid system by drawing aliquots of liquid from said fluid system;

maintaining said negative pressure for a predetermined length of time;

determining a change in volume of said gas bubble; and

converting said change in volume to a leak rate.

56. (Original) The method of claim 40 wherein said sensor comprises:

a light emitter constructed and arranged to emit light through said fluid, said light emitter producing a beam of light, which beam of light, after traveling through said fluid has a first characteristic in the presence of a liquid and a second characteristic in the presence of a gas; and

a light receptor constructed and arranged to receive light from said fluid, said light receptor producing said first signal in response to light having said first characteristic and said second signal in response to light having said second characteristic, wherein said control means may distinguish the presence of said gas or said liquid in said fluid system.

57. (Original) The method of claim 56 wherein said fluid system comprises at least one vessel for containing said fluid, said vessel having at least one wall having a transparent portion, said sensor communicating with said fluid through said transparent portion of said vessel.

58. (Original) The method of claim 57 wherein said vessel is a tube.

59. (Original) The method of claim 58 wherein said tube is transparent.

60. (Original) The method of claim 59 wherein said light emitter is constructed and arranged to pass light into said tube through said at least one transparent portion and said light receptor is constructed and arranged to receive light from said tube through said at least one transparent portion.

61. (Original) The method of claim 59 wherein said sensor is a bubble detector.

62. (Original) The method of claim 40 wherein said fluid system comprises a liquid chromatography system.

63. (Original) The method of claim 40 wherein said fluid system comprises an injector for a liquid chromatography system.

64. (Original) The device of claim 26 wherein said control means determines a volume of fluid to displace from said fluid path in order to position a sample having a known sample volume and located at the tip of said needle to a predetermined location in said sample loop, the determination conducted by subtracting said sample volume and an offset representing said predetermined location from said volume of said fluid path comprised of said sample loop, said valve means in said loop position and said needle.

65. (Original) The device of claim 64 wherein said control means determination includes factors related to pressurization and sample location in said needle.

66. (Original) The method of claim 50 for determining a volume of fluid to be displaced from said fluid path in order to position a sample having a known sample volume at a predetermined location in said sample loop, the method comprising:

subtracting said sample volume from said loop position volume of said fluid path yielding a first intermediate value;

subtracting a volume of said fluid path between a trailing edge of said sample and said tip of said needle from said first intermediate value yielding a second intermediate value; and

subtracting an offset representing said predetermined location from said second intermediate value.

67. (Original) The method of claim 66 wherein said fluid system is pressurized and has a compliance rate volume, said method further comprising: subtracting a compliance volume; and subtracting a fluid transfer volume.

68. (Original) The method of claim 67 wherein said sample is delimited by a leading air gap and a trailing air gap, said method further comprising subtracting a change in volume of said leading air gap due to pressurization from said volume of fluid to be displaced.